8.0 IDENTIFICATION OF IMPORTANT HABITAT FOR NON-FMP SPECIES

Section 303(a)(7) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires the Secretary of Commerce (Secretary) and the Councils to amend FMPs to include the description and identification of essential fish habitat (EFH). Language contained in section 305(b) of the Magnuson-Stevens Act states that "the Secretary, in consultation with participants in the fishery, shall provide each Council with recommendations and information regarding each fishery under that Council's authority to assist it in the identification of essential fish habitat, the adverse impacts on that habitat, and the actions that should be considered to ensure the conservation and enhancement of that habitat." Proposed regulatory guidelines at 50 CFR section 600.805(b) further define the statutory language: "An EFH provision in an FMP must include all fish species in the FMU. An FMP may describe, identify and protect the habitat of species not in an FMU; however, such habitat may not be considered EFH for the purposes of sections 303(a)(7) and 305(b) of the Magnuson Act."(62 FR 19723; April 23, 1997)."

"FMU" or "fishery management unit" is defined at 50 CFR section 600.1 "as a fishery or a portion of a fishery identified in an FMP relevant to the FMP's management objectives. The choice of an FMU depends on the focus of the FMP's objectives, and may be organized around biological, geographic, economic, technical, social, or ecological perspectives." The interim final rule (63FR 66555; December 19, 1997) further clarified this section:

> (b) Optional components. An FMP may include a description and identification of the habitat of species under the authority of the Council, even if not contained in the FMU. However, such habitat may not be EFH. This subpart does not change a Council's ability to implement management measures for a managed species for the protection of another species.

At the Alaska Core Team's meeting in Seattle, WA, in September 1997, a question arose as to whether EFH would have to be developed for all of the species listed in both the GOA and the BSAI groundfish FMPs. Neither the GOA or the BSAI groundfish FMPs use the term "fishery management unit" or "FMU" to describe those species managed under the FMPs. While there are stated management goals and objectives within each groundfish FMP, they alone are not particularly helpful in determining which species are within each FMP's FMU. However, a review of the FMPs in their entirety along with an examination of past and current management practices is informative.

Both groundfish FMPs identify four species categories (there will be five with the addition of a forage fish category, upon approval of Amendments 36/39). The species listed under the categories vary slightly with each FMP but the categories are basically the same in effect. The four categories are: the target species category (pollock, cod, etc.); the "other species" category (sculpins, skates, etc.); the prohibited species category (halibut, herring, etc.); and the nonspecified species category (urchins, rattails, etc.).

Based on a review of the FMP language and the interim final rule, NOAA General Council determined that EFH must be described and identified for those species listed within the target species and other species categories of the GOA and BSAI groundfish FMPs because those species are within the FMPs' FMUs. Conversely, the prohibited species and nonspecified species categories do not appear to be relevant to the FMPs' management objectives and are therefore outside of the FMPs' FMU. Because these species are not within the groundfish FMPs FMUs, there is no requirement to describe and identify EFH for the prohibited species or nonspecified species categories of the GOA and BSAI groundfish FMPs. Nevertheless, "habitat assessments" have been prepared for several non-FMP species (Pacific halibut, Pacific herring, and GOA crab). These species are recognized as important components of the

GOA and BSAI ecosystems. These assessments will be appended to the EFH FMP amendments. However, these assessments will not be considered EFH for the purposes of sections 303(a)(7) and 305(b) of the MSA.

8.1 Pacific Halibut

Habitat and Life History Description for Pacific Halibut
Hippoglossus stenolepis
by
International Pacific Halibut Commission Staff

Life History and Distribution

Pacific halibut are found on the continental shelf of the North Pacific Ocean and the Bering Sea. They have been recorded on the North American coast from Santa Barbara, California to Nome, Alaska and along the Aleutian Islands, and also along the Asiatic Coast from the Gulf of Anadyr, Russia to Hokkaido, Japan. Adult halibut are demersal, living on or near the bottom, and can be found in a wide range of bottom habitat including rock, sand, gravel, and mud. Preferred water temperature is 3 to 8 degrees Celsius (Thompson and VanCleve 1936) although Best and Hardmann (1982) reported finding concentrations of halibut at temperatures as low as 0 degrees Celsius.

From November to March, mature halibut concentrate annually on spawning grounds along the edge of the continental shelf at depths from 185 to 460 meters. The summer months are spent in more shallow coastal waters ranging in depth from 25 to 275 meters.

The major spawning sites in North America are shown in Figure 1 and include Cape St. James, Langara Island (Whaleback), and Frederick Island in British Columbia; Yakutat, Cape Suckling - Yakataga ("W" grounds), Portlock Bank, and Chirikof Island in Alaska. Other reported spawning locations include Goose Islands, Hecate Strait, and Rose Spit in British Columbia, Cape Ommaney, Cape Spencer, and Cape St. Elias in Alaska, and the 200 m edge in the Bering Sea from Unimak Pass to the Pribilof Islands (St-Pierre 1984). In addition to these major grounds, there is reason to conclude that spawning is widespread and occurs in many areas, although not in as dense concentrations as those mentioned above. Evidence to support this conclusion is based on the widespread distribution of sexually mature halibut during the winter months as indicated by research and commercial fishing.

The number of eggs produced by a female is related to its size. A 31 kg[1] female will produce about 500,000 eggs, whereas a female over 151 kg may produce 4 million eggs. The age of 50% maturity is 8 years old for males and 12 years old for females (St-Pierre 1984). The free-floating eggs are about 3 mm in diameter when released and fertilization takes place externally. Developing ova generally are found at depths of 75 to 185 meters, but occur as deep as 500 meters. The temperature at which eggs are found varies from 2.3 to 9.7 degrees Celsius (St-Pierre 1984). The eggs hatch after 15 to 20 days at 5-6 degrees Celsius, and more quickly in warmer water (12 to 14 days at 7-8 degrees Celsius) (McFarlane et al., 1991). The larvae have a greater specific gravity than the eggs and are found below 200 m (St-Pierre 1989), drifting passively in the deep ocean currents. As the larvae grow, their specific gravity decreases and they gradually move towards the surface and drift to shallower waters on the continental shelf. Postlarvae in North American waters may be transported many hundreds of miles by the Alaskan Stream which flows counter-clockwise in the Gulf of Alaska and westward along the Alaska Peninsula and Aleutian Islands. Some of the larvae are carried into the Bering Sea.

Larvae begin life in an upright position with an eye on each side of the head. When the larvae are 2.5 cm long, the left eye moves over the snout to the right side of the head and pigmentation on the left side

[1]All weights in this report are head-on round weight.

fades. When the young fish are about 6 months old and measure 3.5 cm, they have the characteristic adult form and settle to the bottom in shallow inshore areas (Thompson and VanCleve, 1936).

To counter the egg drift with ocean currents in a counter-clockwise direction, the young halibut migrate in a clockwise direction (IPHC 1987). One and two-year-old Pacific halibut are commonly found in inshore areas of central and western Alaska, but are virtually missing from southeast Alaska and British Columbia. They tend to move further offshore at age 2 or 3-years old and can be found off southeast Alaska and British Columbia by age 4 and older. IPHC tagging studies suggest that there is some intermixing of halibut between the North American and Asian populations, but the extent is not known (IPHC 1978).

By the time Pacific halibut are about 8 years old and measure approximately 82 cm, most of the extensive counter-migration to balance egg and larval drift has taken place. However, adult halibut migrate annually, moving to deeper depths on the edge of the continental shelf during the winter for spawning, and into shallow coastal waters in the summer months for feeding (St-Pierre 1984). Although halibut have been caught as deep as 550 meters, they are most often caught between 25 and 275 meters (Table 1).

Adult halibut are long-lived and the largest of all flatfish. The oldest halibut on record to date was 55 years old[2]. Documented weights of up to 303 kg exist; however, few males reach 48 kg and nearly all halibut over 60 kg are females (IPHC 1987).

Removals from the population

The IPHC takes into account all removals of halibut from the North Pacific and Bering Sea within the Exclusive Economic Zones of the U.S. and Canada. Fishing for halibut does occur off the coasts of Japan and Russia, but those removals are not included in the IPHC population assessment.

The IPHC stock assessment is based on biological and fishery data obtained through port sampling, IPHC and National Marine Fisheries Service surveys, and special projects. Since the 1930s, biologists have collected lengths, otoliths for aging and catch per unit of effort data. More recently, IPHC surveys have also collected data on gender composition and maturity. Logbook information is supplied by the fishers either through interviews by IPHC staff in the landing ports or via mail post-season.

In North America, Pacific halibut is removed in a number of ways from the population; targeted commercially, for sport, for personal use, as bycatch in other commercial fisheries, as waste from the halibut fishery, and natural mortality (the IPHC uses a natural mortality rate of 0.2). In 1996, an estimated 42,336 metric tons of directed and non-directed catch was removed from the population (Sullivan and Parma, Unpub. [1997]).

The directed commercial fishery is conducted by hook and line gear only. Fish begin recruiting to this gear type at approximately 60 cm in length, but the commercial minimum size limit is 82 cm. The fishery takes place from March to November ranging from shallow inshore waters to as deep as 275 meters along the continental shelf (Figures 2-10). The directed catch consists of individuals chiefly from 7 to 121 kg. The average size in the commercial catch in 1996 was between 9 and 20 kg depending on the area caught, and the average age was 12 years old (Forsberg, J., Unpub [1997]).

[2] Pers. comm., Forsberg, J.E. IPHC

Today's commercial fishing fleet is diverse, using various types of longline gear and strategies to obtain their quarry. Both Alaska and British Columbia have implemented an individual quota (IQ) system, which enables a vessel to fish anytime between March and November. The U.S. West Coast fishery continues to use short, 10 hour seasons and fishing period limits to manage the fishery.

Interception of juvenile halibut (~30 cm and greater) often occurs in trawl fisheries targeting other groundfish species (such as rock sole, pollock, yellowfin sole, and Pacific cod). Incidental catch of halibut also occurs in groundfish hook and line and pot fisheries. Regulations in both Canada and U.S. currently dictate that all halibut caught incidentally must be discarded regardless of whether the fish is living or dead. These fisheries take place throughout the range of halibut and throughout most of the year. The total mortality of halibut since 1990 has averaged 10,323 metric tons per year (Williams, G.H. Unpub [1997].

Trophic Information

Adult halibut are only rarely found as prey of other fish, and mortality on halibut by marine mammals seems low (Best and St-Pierre, 1986). The size, active nature, and bottom dwelling habits make halibut less vulnerable to predation than other species. However, the juvenile fish are much more vulnerable and are preyed upon by larger groundfish such as Pacific cod.

Halibut are opportunistic, carnivorous feeders. In larval halibut, nutrition is derived from a yolk sac until it is absorbed during the early postlarval stage, about 2 months after hatching. The young fish then begin feeding on zooplankton. Halibut 1 to 3 years old are usually less than 30 cm in length and feed on small shrimp, crab, and fish (Best and Hardman, 1982). As halibut increase in size, fish become a more important part of the diet. They are both benthic and pelagic feeders. The species of fish frequently observed in stomachs of large halibut include cod, sablefish, pollock, rockfish, sculpins, turbot, other flatfish, sand lance, and herring (Best and St-Pierre, 1986; Brodeur and Livingston, 1988). Octopus, crabs, clams, and occasional smaller halibut also contribute to their diet although Pacific halibut do not appear to be a primary predator of these species.

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Table 8.1 Summary of habitat information for Pacific halibut.

Life stage	Age	Diet	Season	Location	Water column	Bottom type	Oceanographic features
Eggs level 0	0-20 days	n/a	November - March	Continental shelf edge - pelagic	75-185 m (found as deep as 500 m)		2-10°C
Larvae level 0	20 days - 2 months	yolk sac	December - May	Continental shelf edge - pelagic	> 200 m		
Post larvae level 0	2 - 6 months	zoo-plankton	January - August	Continental shelf - pelagic	0-200 m		
Juveniles level 1	6 months - 7 years	small crustaceans and fish	Year round	Continental shelf - demersal	25-275 m	Rock, sand, mud, gravel	Prefer 3-8°C
Adults level 2	8+ years	pelagic and demersal fish and crustaceans	(spawning) Nov. - Mar. (not spawning) Mar. -Nov.	(spawning) Cont. shelf edge - demersal (not spawning) Cont. shelf - demersal	(spawning) 185-460 m (not spawning) 25-275 m	Rock, sand, mud, gravel	Prefer 3-8°C

See table of contents for the following figures:

8.2 Pacific Herring

Habitat Description for Pacific Herring
Clupea pallasi

Management Plan and Area(s) Groundfish, BSAI (prohibited species)

Life History and General Distribution In North America, Pacific herring are found from San Diego Bay, California, to Cape Bathurst in the Beaufort Sea (Hart 1973). In Alaska, herring can be found at some time of the year along most of the coastline from Dixon Entrance in Southeastern Alaska to Kotzebue. Pacific herring spawn on submerged vegetation in shallow coastal intertidal and subtidal areas, although substantial spawning occurs on rock substrates in the northern Bering Sea where vegetation is sparse. Spawning is first observed in the southeastern archipelago in mid-march, with spawning in Bering Sea coastal areas occurring during May and June. The eggs are adhesive and cling to nearshore vegetation, often deposited in layers that are several eggs thick. After spawning, adult herring move to offshore feeding areas. The largest concentrations of herring in the Bering Sea spawn along the north shore of Bristol Bay. Following spawning these herring move clockwise along the Alaskan Peninsula, reaching the Unimak Pass area by mid-summer (Funk 1990). Later in the summer these herring move to wintering areas to the north in the general vicinity of the Pribilof Islands (Shaboneev 1968). Smaller concentrations of herring spawn to the north up the Bering Sea coast, but the offshore feeding and wintering grounds for these herring at not well known.

Fishery (e.g., gear types, age at 50% recruitment, when/where conducted, bycatch) Purse seine and gillnet fisheries harvest herring for sac roe on the inshore spawning grounds, just prior to spawning. Age of 50% recruitment in the purse seine fisheries is estimated to be 5, in the gillnet fisheries age 7. In the vicinity of the village of Togiak along northern Bristol Bay coastline, a small locally-based fishery hand picks 170 metric tons of herring spawn on kelp (primarily *Fucus* sp.) annually. A small purse seine fishery for food and bait herring occurs during the summer in the vicinity of Dutch Harbor. Herring are taken as bycatch in trawl fisheries, primarily for pollock, near Unimak pass during the summer months.

Relevant Trophic Information Pacific herring are opportunistic planktivores, and are themselves preyed on by most piscivorous fish and marine mammals.

Potential gear impacts on the habitats of this or other species Except during the spawning period, Pacific herring occur pelagically and are not likely to be impacted by fishing gear impacts on habitat. A small (170 m.t.), controlled amount of spawning substrate is removed annually during the directed spawn on kelp fishery in Bristol Bay. Purse seine or gillnet gear occasionally scrapes the bottom in areas where some spawning substrate is removed. However fishermen generally try to avoid much contact with rocky, kelp-containing substrates to preclude loss or damage to fishing gear.

What is the approximate upper size limit of juvenile fish: 23 cm.

Habitat and Biological Associations

Egg/Spawning: In the Bering Sea, spawning occurs on rocky headlands or in shallow lagoons and bays. Eggs are deposited both subtidally and intertidally on aquatic vegetation. Predominant vegetative types along the Bering Sea coastline are eelgrass (*Zostera spp*), rockweed (*Fucus spp*.), and ribbon kelp (*Laminaria spp*) (Barton 1978). Herring north of Norton Sound spawn in brackish bays and estuaries (Barton 1978). Spawning activity is related to water temperatures and occurs soon after water has become ice-free. Water temperatures on Bering Sea spawning grounds between Norton Sound and Bristol Bay have ranged between 5.6° and

11.7°C (Barton 1979). Optimum temperature for egg development in the laboratory is from 5° to 9°C. Below 5°C, eggs die (Alderdice and Velsen 1971). Eggs take to 10 to 21 days to hatch, depending on the water temperature (Wespestad and Barton 1981). In Bristol Bay, at temperatures to 8° to 11°C, 13 to 14 days are required for hatching (Barton 1979).

Larvae: Newly hatched larvae are about 8 mm in size. Larvae will grow to 30 mm in 6 to 10 weeks and begin to metamorphose into free-swimming juveniles. Larvae are at the mercy of water currents until they develop the ability to swim (Hourston and Haegele 1980). Larvae migrate downwards during the day and to the surface at night, following their planktonic food supply (Hart 1973). Herring larvae and postlarvae feed on ostracods, small copepods and nauplii, small fish larvae, and diatoms (Hart 1973). The first food eaten by larval herring may be limited to relatively small, microscopic planktonic organisms that the larvae must nearly run into to notice and capture. Early food items may be comprised of more than 50% microscopic eggs (Wespestad and Barton 1979). Oceanographic conditions that retain larvae in productive inshore areas is thought to enhance larval survival (Wespestad 1991).

Juveniles: Immature Pacific herring remain offshore and do not participate in the inshore spawning movements of mature adults. The distribution of juvenile herring is not well known. Juveniles consume mostly crustaceans such as copepods, amphipods, cladocerans, decapods, barnacle larvae, and euphasiids. Consumption of some small fish, marine worms, and larval clams has also been documented (Hart 1973). In the western Bering Sea and Kamchatka area in November and December, the diet of juveniles has consisted of medium forms of zooplankton (Chaetognaths, mysids, copepods, and tunicates) (Kachina and Akinova 1972).

Adults: After spawning, herring move to offshore feeding and overwintering areas and are not closely associated with the bottom and likely not affected by bottom substrates. Adults were found to overwinter at depths of from 107 to 137 m in the Bering Sea (Dudnik and Usoltsev 1964). In the Bering Sea, temperature may have the greatest influence on the seasonal distribution of herring (Wespestad and Barton 1981). Dense schools of overwintering adult herring have been found at temperatures of from 2 to 3.5°C in the Bering Sea (Dudnik and Usoltsev 1964). Herring moving from the overwintering grounds in the Bering Sea to spawning grounds have passed through water at subzero temperatures (Wespestad and Barton 1981). Immature herring may occupy less saline waters than adults (Taylor 1964). Juveniles, however, are found in a wide range of salinities in British Columbia, with most concentrations located at 25 parts per thousand (o/oo) (Hourston 1959). Herring eggs and fry were found in Imuruk Basin near Port Clarence, Alaska, in water of 4 o/oo salinity (Barton 1978). Immature fish in the Bering Sea exhibit greater tolerance or preference for colder, less saline areas on their overwintering grounds on the continental shelf than do adult fish (Wespestad and Barton 1981). The timing of spawning in the western Bering Sea is related to winter and spring water temperatures, with early maturation occurring in warm years and delayed development in colder years (Prokhorov 1968). In Bristol Bay and Port Heiden, herring appeared on the spawning grounds when temperatures reached 6°C.

In the eastern Bering Sea, August diets of adults were comprised of 84% euphausiids, 8% fish fry, 6% calanoid copepods, 2% gammarid amphipods; fish fry, in order of importance, were walleye pollock, sandlance, capelin, and smelt. During spring months, food items were mainly Themisto (amphipoda) and Sagitta (chaetognath). After spawning (eastern Bering Sea), adults preferred euphausiids, copepods (Calanus spp.), and arrow worms (Sagitta spp.) (Dudnik and Usoltsev 1964). In demersal areas, stomach contents included polychaete worms, bivalve molluscs, amphipods, copepods, juvenile fish, and detritus (Kachina and Akinova 1972), Barton (1978) found cladocerans, flatworms (Platyhelminthes), copepods, and cirripeds in herring captured during spring months. Rather than exhibiting a preference for certain food items, adult herring feed opportunistically on any large organisms predominating among the plankton in a given area (Kaganovskii 1955).

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Location of the spawning and winter grounds (oval areas) of main eastern and western Bering Sea herring stocks and routes of migration of eastern stocks to spawning areas.

SPECIES: Pacific Herring

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs level 2	10-21 days	NA	Spring	BCH	D	K, SAV, R		
Larvae level 0	2-3 months	Small zooplankton, eggs	Spring/ Summer	Bay ICS	P	NA	G	
Juveniles level 0	1-5 years	Opportunistic zooplanktivore	All year	ICS MCS OCS	P	NA	F, E	
Adults level 2	5+ years	Opportunistic zooplanktivore	Spawning (May-June) Other	BCH Bay Bay ICS MCS OCS	P P	NA NA	F, E	

8.3 GOA Crab Species

Habitat Description for GOA Red King Crab

Paralithodes camtschaticus

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska

Life History and General Distribution

Red king crab (*Paralithodes camtshaticus*) is widely distributed throughout the Bering Sea and Aleutian Islands, Gulf of Alaska, Sea of Okhotsk, and along the Kamchatka shelf. On the coast of North America it is found from Point Barrow, Alaska, to the Queen Charlotte Islands and waters adjacent to mainland northern British Columbia. Red king crab occupy depths from the intertidal region (young-of-the-year crabs) to 366 meters. Red king crab molt several times per year through age 3 after which molting is annual. At larger sizes, king crab may molt less frequently than annually as growth slows. Females grow more slowly and do not attain the size of males. In the northeastern Gulf of Alaska, fifty percent maturity is attained by females at 106 mm (about 6 yrs.). Natural mortality of adult red king crab males increases with size and has been estimated to reach about 25 percent per year (M=0.3) in crab greater than 135 mm carapace length, owing to old age, disease, and predation.

Fishery

Red king crab fisheries have been prosecuted in the Gulf of Alaska since 1954. The gear has evolved to include side loading mesh covered pots approximately 6 to 8 feet square and top loading pyramid or conical style gear. Discrete populations are found in the Alaska Peninsula, Kodiak, Cook Inlet, Prince William Sound and Southeastern Management areas.

Historically, the red king crab fishery has been Alaska's top shellfish fishery. Since the mid-1950's fishermen have harvested over 1 billion pounds of red king crab from Gulf of Alaska waters. The peak harvest came in 1965 when approximately 113 million pounds were landed from the five management areas. The Kodiak area was the major contributor at 94 million pounds. A near peak harvest occurred in the 1980/81 season, but three years later the fishery had crashed with the harvest down sixty-fold and all management areas in the Gulf closed completely for the first time.

A long period in which few juvenile king crab survived to adult size preceeded the crash. A combination of overfishing, fish predation on king crab, and a warmer ocean environment were the likely contributing factors for the current low stock size of red king crabs in the Gulf of Alaska. Their populations remain depressed and fisheries have not been open since 1983 with the exception of a small fishery in inside waters of Southeastern Alaska, that has occurred yearly since 1993.

Relevant Trophic Information

Subadult and adult Red King Crabs eat a variety of benthic invertebrates including clams, cockles, snails, barnacles, amphipods, crabs, polychaetes, hydroids, brittle stars, sand dollars, sea urchins and sea stars, and fishes such as Capelin (*Mallotus villosus*), Pacific Sand Lance (*Ammodytes hexapterus*), and Pacific Herring (*Clupea pallasi*). At least some of these fish are probably scavenged. A total of 98 different species were found in the stomachs of Red King Crabs from depths of 50 to 200 meters (164 to 656 feet) in late winter and late spring on the Kodiak Shelf. Red King Crabs in the Okhotsk Sea have been found to prefer

echinoderms and barnacles (*Balanus* sp.) just prior to and after molting. These species provide a good source of calcium carbonate which the crabs may need to replace that lost during ecdysis (molting).

The zoeae of the Red King Crab are planktivores, consuming both phytoplankton and zooplankton. Stomach contents of the third and fourth zoeal stages collected in Cook Inlet, Alaska, included diatoms and the larvae of barnacles and the Helmet Crab (*Telmessus cheiragonus*). In the laboratory, the larvae will eat diatoms, crustacean nauplii, copepods, polychaete larvae and rotifers. In Auke Bay, Alaska, the larvae feed during the day at a depth of 5-10 meters (16-33 feet) and not at night. This feeding periodicity is consistent with the reverse diel vertical migration exhibited by Red King Crab larvae in Auke Bay.

Young-of-the-year Red King Crab eat diatoms, foraminiferans (protozoans with calcareous shells), sponge tissue, hydroids, bryozoans, polychaetes, bivalves, gastropods, ostracods, harpacticoid copepods, and sand dollars. In the laboratory postlarval, 1-year-old, and 2-year-old Red King Crabs are cannibalistic. The frequency of cannibalism in 1-year-old crabs depends on the quality of the diet fed to them, crab density and the complexity of the habitat. The frequency of cannibalism in 2-year-old crabs does not depend on crab density or the availability of cover in the laboratory.

A variety of predators consume the various life stages of the Red King Crab. The eggs are preyed upon by at least three species of nemertean worm: *Carcinonemertes regicides*, an undescribed small eyeless species, and *Alaxinus oclairi.* The first two species are the most widespread and abundant nemertean egg predators on Red King Crabs. The gammarid amphipod *Ischyrocerus* sp. also preys on Red King Crab eggs. Walleye pollock (*Theragra chalcogramma*) preys on larval king crab. Yellowfin Sole (*Limanda aspera*) eat large numbers of the glaucothoe stage. Juvenile and adult crabs are preyed upon by Pacific Cod (*Gadus macrocephalus*), Pacific Halibut (*Hippoglossus stenolepis*), sculpins (*Hemilepidotus* and *Myoxocephalus*), the Korean Hair Crab (*Erimacrus isenbeckii*), octopus (*Octopus* sp.) and the Sea Otter (*Enhydra lutris*).

What is the approximate upper size limit of juvenile fish (in cm)?
The size of 50 percent maturity is 10 cm carapace length for female red king crabs from the northeastern Gulf of Alaska.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

Egg/Spawning See Adults.

Larvae The larval stages consist of a prezoeal stage and four zoeal stages. The first post larval stage is the glaucothoe. The prezoeal stage lasts a few minutes, the zoeal stages each last 2-4 weeks, and the glaucothoe lasts 3-4 weeks. Metamorphosis to the first benthic stage occurs 3-4.5 months after hatching. Red king crab larvae occupy the upper 40-100 meters of the water column depending on the geographical area. The position of the larvae in the water column varies with the time of day. In Auke Bay, Alaska, red king crab larvae

exhibit reverse diel vertical migration. The larvae are most abundant at 5 to 10 meters (16 to 33 feet) during the day and at 30 meters (98 feet) at night. A similar pattern of vertical migration has been observed at Kodiak Island, Alaska. The first and second stage zoeae of red king crab females from Auke Bay tolerate temperature/salinity combinations for short periods that exceed the range to which they are exposed in nature. Stage I zoeae show high survival at temperatures from 0 to 12 C (32 to 54 F) and salinities of 20 to 30 ppt. Stage II zoeae show highest survival at temperatures from 0 to 6 C (32 to 41 F) and salinities of 20 to 30 ppt. Stage I and II zoeae studied in Japan showed similar temperature and salinity tolerances as those at Auke Bay. At Auke Bay, stage II zoeae preferred more saline conditions (29.4 ppt) than did stage I zoeae (27.5 ppt). Zoeae exposed to low salinity water passively sink until they reach higher salinity.

Juveniles Young-of-the-year crab occur at depths of 50 m or less. They are solitary and need high relief habitat or coarse substrate such as boulders, cobble, shell hash, and living substrates such as bryozoans and stalked ascidians. Between the ages of two and four years, there is a decreasing reliance on habitat and a tendency for the crab to form pods consisting of thousands of crabs. Podding generally continues until four years of age (about 6.5 cm), when the crab move to deeper water and join adults in the spring migration to shallow water for spawning. The remainder of the year crab are found in deep water. Juvenile crabs are somewhat more tolerant of reduced salinities than adults (see below).

Adults Adult and older juvenile red king crabs occur on a variety of substrata including rock or gravel (especially nearshore) and mud, sand, shell fragments or mixtures of these substratum types. Mating crabs often occur in areas with kelp (*Alaria, Costaria* and *Laminaria*). The kelp can provide cover for the courting pair when the female is soft and vulnerable to predation following molting. Red king crab do not osmoregulate and cannot tolerate low-salinity water. Adults show signs of stress when immersed in sea water of less than about 18 ppt salinity. Red king crabs exhibit seasonal migration. Adult crabs occupy deeper offshore areas in summer. In late fall and early winter the crabs migrate onshore to shallow waters prior to larval hatching, molting of females, mating and egg extrusion which takes place from January through June depending on the geographical area. After this period of reproduction the crabs return to deep water. In southeastern Alaska, red king crab mate when they enter shallower waters (<50 m), generally beginning in January and continuing through June. Males grasp females just prior to female molting, after which the eggs are fertilized and extruded onto the pleopods of the female's abdomen. In the northeastern Gulf of Alaska fecundity ranges from 148,300 to 446,600 eggs for females ranging in carapace length from 128 to 145 mm (5 to 5.7 in). The female red king crab carries the eggs for 11-12 months before they hatch, generally in March through May. Hatching of king crab larvae is temporally synchronized with the spring phytoplankton bloom in southeastern Alaska.

SPECIES: Red king crab, *Paralithodes camtschaticus*

Stage - EFH	Duration or	Diet/Prey	Season/Time	Location	Water	Bottom	Oceanographic	Other
Eggs 1	11- 12 mo	NA	May-April	NA	NA	NA	NA	
Larvae 1	3-4.5 mo	Diatoms, Crustacean larvae	April-August	BAY, ICS	P	NA	F	
Juveniles 1	1 to 5-6 yrs	Diatoms Hydroids Polychaetes Mollusks, Harpacticoid copepods Bryozoans	All year	BCH, BAY ICS	D	SAV (epifauna), R, CB, G	NA	Found among biogenic assemblages (sea onions, tube worms, bryozoans,
Adults 1	10-15 yrs	Mollusks, echinoderms, polychaetes, decapod, crustaceans, Algae, urchins, hydroids, sea stars	Spawning Feb- June	ICS, BAY, BCH	D	S, M, CB, G	CL	

Habitat Description for GOA Blue king crab
Paralithodes platypus

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

The Blue King Crab ranges discontinuously from Kamchatka to Hokkaido, Japan and from Kotzebue Sound, Alaska, to southeastern Alaska. In the Gulf of Alaska, small populations have been found in Olga Bay at Kodiak Island, Port Wells in Prince William Sound, and Russell Fiord, Glacier Bay, Lynn Canal and Endicott Arm in southeastern Alaska. Blue king crab molt many times as juveniles. In Olga Bay, 50 percent maturity of females is attained at 9.4 cm carapace length, which occurs at about 5 years of age. Blue king crab in Prince William Sound mature at a somewhat smaller size (50 percent maturity at 8.7 cm carapace length for females). Male size at maturity has been found to be 8.7 and 9.3 cm carapace length at Olga Bay and Prince William Sound, respectively. Skip molting occurs with increased probability in males larger than 10 cm carapace length. Larger female blue king crab have a biennial ovarian cycle and a 14 month embryonic period. Unlike red king crab, juvenile blue king crab do not form pods, instead rely on cryptic coloration for protection from predators. Adult male blue king crab occur at an average depth of 70 m and an average temperature of 0.6 degrees C.

Fishery

Blue king fisheries have been prosecuted using mesh covered pots. Landings have been relatively minor with records combined with red king crab for the most part. Some harvest has occurred from the Kodiak, Prince William Sound and Southeastern Alaska areas. The highest recorded catch was 13,000 pounds from Prince William Sound in 1979.

Relevant Trophic Information

Little information is known on the diet or predators of the blue king crab in the Gulf of Alaska. Pacific cod prey on soft-shell blue king crabs, and walleye pollock and yellowfin sole prey on the glaucothoe in the Bering Sea.

What is the approximate upper size limit of juvenile fish (in cm)?

The size of 50 percent maturity is 9.4 cm carapace length for females from Olga Bay, and 8.7 cm for Prince William Sound. Male size at maturity has been found to be 8.7 and 9.3 cm carapace length at Olga Bay and Prince William Sound, respectively.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

Egg/Spawning See Adults.

Larvae Blue king crab spend 3.5 to 4 months in pelagic larval stages before settling to the benthic life stage. Larvae are found in waters of depths between 40 to 60 m.

Juveniles Juvenile blue king crab require refuge substrate characterized by gravel and cobble overlaid with shell hash, and sponge, hydroid and barnacle assemblages. These habitat areas have been found at 40-60 m around the Pribilofs Islands. The habitat requirements of juvenile blue king crab have not been studied in the Gulf of Alaska.

Adults Adults occur most often between 45-75 m depth on mud-sand substrate adjacent to gravel rocky bottom. Female and juvenile crab are found in a habitat with a high percentage of shell hash. It has been suggested that spawning and successful recruitment of first in-star juveniles may depend on availability of nearshore rocky-cobble substrate for protection of both females and small juveniles. Spawning occurs in mid-spring. Larger older females reproduce biennially while small females tend to reproduce annually. Fecundity of females range from 50,000-200,000 eggs per female. Larger older crabs disperse farther offshore and are thought to migrate inshore for molting and mating.

SPECIES: Blue king crab, *Paralithodes platypus*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs 1	14 mo.	NA	Starting April-May	BAYS	NA	NA	F	
Larvae 1	3.5 to 4 mo.		April-July	BAYS	P	NA	F	
Juveniles 1			All year	BAYS	D	CB, G, R	F	
Adults 1			Spawning Feb-Jun	BAYS	D	S, M, CB, G, R	F	

Habitat Description for GOA Golden king crab

Lithodes aequispina

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

Golden king crab (*Lithodes aequispina*), also called brown king crab, range from Japan to the Sea of Okhotsk and the Bering Sea to British Columbia. In the north Pacific, golden king crab are found at depths from 120 m to 900 m. Golden king crab are usually found in high relief habitat such as inter-island passes and fiords, and often inhabit slopes. Size at sexual maturity depends on latitude ranging from 9.8 - 11 cm carapace length, with crabs in the northern areas maturing at smaller sizes. The fecundity of females in northern British Columbia ranges from 10,620 to 27,040 eggs for females ranging in size from 11 to 15 cm. The season of reproduction appears to be protracted, and may be year-round.

Fishery

The golden king crab fisheries are prosecuted using mesh covered pots. Some landings have occurred from the Kodiak and Prince William Sound areas but the primary fishery has occurred in Southeast Alaska. Since the mid-1960's there has been approximately 10 million pounds harvested. The peak catch of 1.0 million pounds occurred in the 1986/87 season. The fishing season runs from February 15 until closed by emergency order.

Relevant Trophic Information

Trophic information on the golden king crab in the Gulf of Alaska is lacking. In the Bering Sea the crab eats a variety of invertebrates including sponges, hydroids, polychaetes, mollusks, amphipods, decapod crustacea, ophiuroids, echinoids and fish.

Describe any potential gear impacts on the habitats of this or other species

What is the approximate upper size limit of juvenile fish (in cm)?

The size (carapace length) at 50% maturity for females in northern British Columbia is 10.6 cm; the size at maturity for males is 11.4 cm.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

Golden king crab occur on hard bottom, over steep rocky slopes and on narrow ledges. Strong currents are

prevalent. Golden king crab coexist with a diverse group of epifauna, including sponges, hydroids, coral, sea stars, bryozoans, and brittle stars.

Egg/Spawning Eggs brooded by females collected in southeastern Alaska and brought into the laboratory in March hatched from April to August. The total duration of hatching was 123 d.

Larvae Golden king crab larvae are lecithotrophic. The zoeal and glaucothoe stages last 2.2 months and probably occupy near-bottom waters before settling to the benthic life stage.

Juveniles Juvenile golden king crab are found throughout the depth range of the species. In British Columbia, juvenile crab are most common at depths >100 m.

Adults Adult crabs occur at all depths within their distribution. In northern British Columbia, males are less migratory and tend to inhabit shallower waters than females. Males are found from 50 to 150 m. Females usually mate and extrude eggs at <150 m, and brood eggs from 150 to 250 m. Post-spawned females are found from 200 to 400 m.

SPECIES: Golden king crab, *Lithodes aequispina*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs 0				IP, BAY, OCS, USP		R		
Larvae 0	2.2 mo	Yolk			SP			
Juveniles 0						R		
Adults 0		Ophiuroids, sponges, plants, polychaetes, amphipods, echinoids, hydroids	Spawning Feb.-Aug.			R		

Habitat Description for GOA Scarlet king crab
Lithodes couesi

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

The scarlet king crab (*Lithodes couesi*) is distributed from Onohama, Japan to the Bering Sea to San Diego, California. It is a deep water species found primarily on the continental slope and on seamounts in the depth range 258 to 1829 m. Little information is available on the biology of the scarlet king crab. Spawning may be asynchronous. Fecundity increases up to a size of 9.5 cm carapace length (CL), then remains relatively constant as size increases further. Fecundity ranges from 2,700 to 5,500 eggs in females ranging in size from 8.3 to 11.5 cm CL. Crabs have been observed brooding eggs in June and July in the Gulf of Alaska; crabs have not been sampled in other months.

Fishery

Directed fishing for scarlet king crab may only occur under conditions of a permit issued by the Commissioner of Fish and Game. Fishing operations are restricted to pot gear only in waters 200 fathoms or greater in depth. Exploratory fishing has been minor with only a few small landings recorded from the Gulf of Alaska.

Relevant Trophic Information

Unknown.

What is the approximate upper size limit of juvenile fish (in cm)?

The estimated size (carapace length) of 50% maturity for female and males is 8 cm and 9.1 cm in the Gulf of Alaska.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

On seamounts adult and subadult scarlet king crab are associated with steep rocky outcrops and narrow ledges interspersed with sediments. The species is also found on the continental slope of southeastern Alaska. Strong currents are often prevalent in these habitats.

Egg/Spawning Eggs are large, averaging 2.3 mm in length.

Larvae Stage 1 zoeae of *L. couesi* have substantially more yolk than red king crab (Paralithodes camtschaticus) suggesting that they may be lecithotrophic. The distribution of *L. couesi* larvae in the water column is not known.

Juveniles Subadults have been collected in the same habitats as adults on seamounts (see below).

Adults In the Gulf of Alaska, adults have been found on seamounts in the depth range 384 to 850 m. The species occurs deeper (> 592 m) on the continental slope in southeastern Alaska.

SPECIES: Scarlet king crab, *Lithodes couesi*

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs 0				USP, LSP		R		
Larvae 0								
Juveniles 0				USP		R		
Adults 0				USP, LSP		R		

Habitat Description for GOA Tanner crab
Chionoecetes bairdi

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
Tanner crabs (*Chionoecetes bairdi*) are distributed on the continental shelf of the North Pacific Ocean and Bering Sea from Kamchatka to Oregon. In Alaska, Tanner crabs are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula, and are found in lower abundance in the Gulf of Alaska and throughout the Alexander Archipelago. Crabs occur from the littoral zone to 473 m. Females reach a terminal size with their maturity molt. Large numbers of small-clawed males migrate into shallow waters (<18 m) of Southeast Alaska bays and inlets to molt en masse in March and April. Mature male Tanner crabs may skip a year or more of molting after they attain maturity. Adult male crabs have limited migratory movements. Female crabs also have limited annual migrations especially while brooding eggs. Eggs generally hatch from March through May in the Gulf of Alaska, and peak hatching occurs in early May in Southeast Alaska (Robert Stone, NMFS, Auke Bay Laboratory, personal observation).

Fishery
The Tanner crab fisheries have been prosecuted in the Gulf of Alaska since 1967. Approximately 700 million pounds have been harvested since that time. The gear has evolved to include side loading mesh covered pots approximately 6 to 8 feet square and top loading pyramid or conical style gear. Fisheries have occurred in the South Peninsula, Chignik, Kodiak, Cook Inlet, Prince William Sound, Yakutat and Southeast Alaska Management Areas. The peak harvest of 54 million pounds was taken in 1978 with the Kodiak area contributing 33 million pounds. Tanner crab populations and fisheries diminished after that time with no harvest from the South peninsula and Chignik areas after 1989. Prince William Sound has remained closed since 1988. Kodiak and Cook Inlet had their most recent fisheries in 1994. Small fisheries continue to occur in Yakutat Bay and Southeast Alaska. The fishing season runs from February 15 through May 1.

Relevant Trophic Information
Tanner crab larvae are planktotrophic feeding on phytoplankton and small zooplankton. Crabs of different size, sex and state of maturity consume similar prey species, but diet differs from one area to another depending on prey availability. Food of juvenile crabs includes other crabs, bivalves, polychaetes, ophiuroids, barnacles, and sediment. Cannibalism may be prevalent in juvenile crabs. Adults near Kodiak are opportunistic and feed mainly on arthropods (mainly juvenile *C. bairdi*), fish, mollusks and polychaetes. In Southeast Alaska, polychaetes constitute a large portion of the diet of adult crabs.

Throughout their range *Chionoecetes* spp. are prey for at least seven species of invertebrates, twenty-six species of fishes, and four species of marine mammals. Pacific cod (*Gadus macrocephalus*) is the main predator on Tanner crabs in the Kodiak Island area; crabs up to 70 mm CW are consumed but most are between 7 and 23 mm CW. Sculpins (*Myoxocephalus* spp.) are also an important predator of crabs in the Kodiak area, including ovigerous females. Both adult and juvenile *C. bairdi* are cannibalistic. Other demersal fishes, including the yellow Irish Lord (*Hemilepidotus jordani*), are important predators. Larval predators include salmon, herring, jellyfish and chaetognaths. In the Gulf of Alaska juvenile coho salmon (*Oncorhynchus kisutch*) are important predators of Tanner crab zoeae[3]

Describe any potential gear impacts on the habitats of this or other species

Bottom trawls and dredges could disrupt nursery and adult molting and mating areas.

What is the approximate upper size limit of juvenile crab (in mm)?

One hundred percent of male *C. bairdi* 80 mm CW from the GOA are sexually mature as determined from the presence of spermatophores in the vas deferens and mating experiments. Estimates of the median size at maturity (SM_{50}) or mean size at maturity for Kodiak Island males are between 100 and 115 mm CW. The size of 50% maturity for females (50% have undergone the molt to maturity) was estimated at 83 mm CW. Since females do not continue to grow after maturity, measuring the mean size of a sample of multiparous females would reflect the mean size at maturity. Using this method, the mean size at maturity would be 97.3 mm CW for Kodiak Island females and 103.7 mm CW for Southeast Alaskan females.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801

[3] Pers. comm., Mary Auburn-Cook, NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Juneau AK.

ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

In May and June, Age 1 crabs are abundant in Cook Inlet at 150 m depth in areas where small sponges, hydroids, and polychaete tubes dominated the benthic community. Ovigerous female crabs often bury in the sediment while brooding eggs.

Egg/Spawning See Adults

Larvae There are two zoeal stages which inhabit the upper and middle zones of relatively shallow water in Cook Inlet. Larvae are strong swimmers and perform diel vertical migrations in the water column (down at night). They usually stay near the depth of the chlorophyll maximum during the day. The length of time larvae take to develop is unknown, although it has been estimated at only 12 to 14 days. The first benthic stage (megalops) settles on the bottom.

Juveniles In Southeast Alaskan bays young-of-year crab (8 to 15 mm CW) are locally abundant in early fall on silt/fine sand slopes between 4 and 10 m depth (Robert Stone, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). Age 2 crab (34 to 48 mm CW) are locally abundant in similar habitat between 10 and 20 m depth during spring. Numerous crabs < 40 mm were observed from a submersible on silt substrate at 225 m depth along the Southeast Alaska coast. These observations indicate that juveniles are either widely distributed or make extensive seasonal migrations with respect to depth.

Adults *C. bairdi* females have a terminal molt at maturity and breed for the first time in the soft-shelled state. In subsequent years multiparous crabs breed in the hard-shelled state and may use stored sperm to fertilize their eggs. Pubescent females molt and mate between January and May in nearshore waters (3-13 m) near Kodiak and between late-December and mid-June in the nearshore waters (4-19 m) of Southeast Alaska. Near Kodiak Island multiparous females are known to form high density mating aggregations consisting of hundreds of crabs per mound. These mounds may provide protection from predators and also attract males for mating. In Southeast Alaska, however, multiparous females have been observed mating in low-density aggregations in shallow water (including the intertidal zone) during May. Females have clutches of 50,000 to 400,000 eggs. Multiparous females annually produce an average of 170,000 eggs. Multiparous females carry and brood the embryos for one year after fertilization. Primiparous females may carry the fertilized eggs for as long as 1.5 years.

SPECIES: Tanner crab, *Chionoecetes bairdi*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs 1	1 to 1.5 years	NA	All Year	ICS, MCS, OCS	D	Silt/Fine Sand		Carried by ovigerous female
Larvae 0	Unknown (12-14 d)	Diatoms Algae Zooplankton	April-September	MCS, ICS	P	NA	F	
Juveniles 1	1 to 5 years	Crustaceans polychaetes bivalves ophiuroids algae hydroids	All year	MCS, ICS, BAY,	D	Silt/Fine Sand		
Adults 1	5+ years	Polychaetes crustaceans mollusks hydroids	Spawning Late-December to June (peak April-May)	MCS, ICS	D	Silt/Fine Sand		

Habitat Description for GOA Grooved Tanner crab
Chionoecetes tanneri

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
In the North Pacific Ocean the grooved Tanner crab (*Chionoecetes tanneri*) ranges from northern Mexico to Kamchatka. Little information is available on the biology of the grooved Tanner crab; existing information is from surveys conducted off the Oregon and British Colombian coasts and the Eastern Bering Sea. This species occurs in deep water (to 1925 m)of the outer continental shelf and continental slope and is uncommon at depths < 300 m. Male and female crabs are found at similar depths, especially during winter when mating probably occurs.

Fishery
Directed fishing for grooved Tanner crab may only occur under condition of a permit issued by the Commissioner of Fish and Game. The Gulf of Alaska was initially explored for deepwater Tanner crab in 1994. Six vessels participated in 1995 and landed 947,000 pounds. Most of the fishing occurred on the bank of continental shelf from 375-475 fathoms. Interest and landings declined in 1996 as the value of Tanner crab declined. There have been no landings since that time.

Relevant Trophic Information
Juvenile crabs (3-10 mm CW) are preyed upon by sablefish (*Anoplopoma fimbria*) and Dover sole (*Microstomus pacificus*).

What is the approximate upper size limit of juvenile fish (in mm)?
The SM_{50} (size at 50% maturity) is estimated at 119 mm CW for males and 79 cm CW for females in the eastern Bering Sea.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

Egg/Spawning See Adults

Larvae Like other *Chionoecetes* spp., *C. tanneri* has a brief prezoeal stage followed by two zoeal stages and a megalops. The total pelagic period of the larvae is estimated at about 80 days. Larvae are probably planktotrophic and must migrate vertically to feed in surface waters where prey concentrations are greater. Larvae probably hatch during winter off the Oregon coast.

Juveniles Juvenile *C. tanneri* occur in shallower water than mature male crabs in the eastern Bering Sea.

Adults In the Eastern Bering Sea adult males may be found somewhat more shallower than females but sexes do not show clear segregation by depth. All reproductively active females mate and extrude eggs at about the same time of year. Mean fecundity of *C. tanneri* is 86,500 eggs. Reproduction is probably

seasonal and synchronous and mating probably occurs during winter but as late as July. Like other members of the genus *Chionoecetes*, females probably have a terminal molt. Shell condition data suggest that male grooved Tanner crab continue to molt after maturity.

SPECIES: Grooved Tanner crab, *Chionoecetes tanneri*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	1 year	NA	All Year	USP, LSP	NA	Silt		
Larvae	About 80 days	Plankto-trophic	Late-Winter to ?		P	NA		
Juveniles	Unknown	Unknown	All Year	OCS,USP, LSP	NA	Silt		
Adults	Unknown	Polychaetes, crustaceans, ophiuroids	All Year	USP, LSP	NA	Silt		

Habitat Description for GOA Triangle Tanner crab
Chionoecetes angulatus

Management Plan and Area(s)
No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution
In the eastern North Pacific Ocean the triangle Tanner crab (*Chionoecetes angulatus*) ranges from Oregon to the Sea of Okhotsk. Little information is available on the biology of the grooved Tanner crab; existing information is mostly from one survey conducted in the Eastern Bering Sea. This species occurs on the continental slope in depths > 300 m and has been reported as deep as 2,974 m in the eastern Bering Sea . Mature male crabs inhabit shallower depths (mean 647 m) than mature females (mean 748 m) in the eastern Bering Sea possibly indicating seasonal segregation by depth.

Fishery
Directed fishing for triangle Tanner crab may only occur under the conditions of a permit issued by the Commissioner of Fish and Game. There have not been any landings recorded from the Gulf of Alaska.

Relevant Trophic Information
Unknown.

Describe any potential gear impacts on the habitats of this or other species

What is the approximate upper size limit of juvenile fish (in cm)?
In the eastern Bering Sea, male triangle Tanner crabs reach 50% maturity at 91 mm CW and females at 58 mm CW.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative

Unknown

Egg/Spawning See Adults

Larvae Larvae are probably planktotrophic and must migrate vertically to feed in surface waters where prey concentrations are greater.

Juveniles Juvenile males are found at similar depths (650 m) as mature males.

Adults The mean depth occupied by mature males (647 m) is significantly less than that of mature females (748 m) indicating some pattern of sexual segregation by depth. Adult male crabs probably molt in June or July. All reproductively active females mate and extrude eggs at about the same time of year. Fecundity of triangle Tanner crabs increases with size. Females of 70 mm CW are estimated to have approximately

40,000 - 50,000 eggs. Reproduction is probably seasonal and synchronous and mating probably occurs during winter but as late as July. Like other members of the genus *Chionoecetes*, females probably have a terminal molt. Shell condition data suggest that male triangle Tanner crab continue to molt after maturity.

SPECIES: Triangle Tanner crab, *Chionoecetes angulatus*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	Probably 1 year	Unknown	All year	USP, LSP	NA	Silt		
Larvae	Unknown	Unknown	Late-winter and spring ?	NA	P			
Juveniles	Unknown	Unknown	All year	USP, LSP	NA	Silt		
Adults	Unknown	Unknown	All year	USP, LSP	NA	Silt		

Habitat Description for Dungeness Crab
Cancer magister

Management Plan and Area(s)

No federal fishery management plan exists for the commercial king, Tanner and Dungeness crab fisheries in the Gulf of Alaska.

Life History and General Distribution

The Dungeness crab is distributed from the Pribilof Islands, Alaska, to Santa Barbara, California. A single specimen has been collected on Amchitka Island, Alaska; the published western limit of distribution is Tanaga Island, Aleutian Islands, Alaska. The species is found from the intertidal region to a depth of 230 meters. In northern Puget Sound, Washington, males and females reach sexual maturity at 10.0 cm in width in their second year of life. Females mate for the first time in their second year; males mate first in their third year. In southeastern Alaska, male/female pairs have been observed in premating embrace from May to December (Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation), but the peak period of mating is July to October has seen. In more southern waters crabs mate from April to September in British Columbia, and March to June in Washington. Males embrace smaller females about to molt for seven to eight days. Mating occurs about an hour after the female molts. During mating the male deposits spermatophores in the spermathecae (receptive organs) of the female. Mating lasts up to two hours or more. After mating in the laboratory, the male embraces the female again for two days. In nature, males have been observed standing over or near buried females with soft exoskeletons. Presumably the male is guarding the female until her new exoskeleton hardens. A female can retain viable sperm through a molt as well as retain sperm for at least 2.5 years and use it to fertilize an egg clutch that develops normally.

In Washington, both sexes migrate offshore away from estuaries after the mating season. Females might undertake these migrations to avoid exposure of their eggs to osmotic stress when the eggs are extruded. In Oregon, female crabs migrate inshore in order to reach the sandy bottoms they require for the proper formation of their egg clutches at the time of egg extrusion. In southeastern Alaska, the females mate and brood their eggs in shallow water (less than 10 m) on sandy bottoms in estuaries. Ovigerous crabs often aggregate in sandy areas near stream mouths, and are presumably exposed to low salinities in these areas.

Fertilization of the eggs takes place when the female extrudes the eggs onto the setae of her pleopods. Egg extrusion usually occurs several months after mating. In Southeastern Alaska, egg extrusion occurs in August-October; September-February in British Columbia, and October-December in Washington and Oregon. Fecundity ranges from 134,100 to 1,545,940 eggs/brood in females ranging in carapace width from 11.0 to 16.6 cm.

Hatching occurs in late April-June in southeastern Alaska. For those females in glacial systems, hatching takes place when glacial runoff is high and surface salinities are low. In the Queen Charlotte Islands hatching occurs in late April, throughout British Columbia in December-June, and in Washington in January-April. The larvae hatches as a prezoea and molts to the first zoeal stage within an hour. The five zoeal stages and the megalopal stage together last 90-110 d at 10°C; the megalopal stage alone lasts 25-30 d.

The period of peak settlement of Dungeness crab megalopae varies with latitude. Throughout British Columbia settlement occurs in July or later (in the Queen Charlotte Islands it peaks in late August-September); May to August in Washington. The first juvenile stage appears in greatest numbers in late May or early June at a carapace width of about 0.7-0.8 cm. The maximum age of the Dungeness crab is about eight years.

Fishery

Dungeness fishing in the Gulf of Alaska dates back to the 1930's. Prior to 1960, landings were combined into a single total. Since then, catch records detail harvest from the Alaska Peninsula, Kodiak, Cook Inlet, Prince William Sound, Yakutat and Southeast Alaska management areas. All registration areas in Alaska apply generally passive management measures limiting the size and sex of harvested animals. Gear has been limited to pots or ring nets with two escape rings of 4 3/8" diameter required in each pot. Since 1960, approximately 263 million pounds of Dungeness crab have been harvested from the Gulf of Alaska.

Relevant Trophic Information

Dungeness crabs are generalist predators that consume a variety of invertebrates and fish. A large part of the diet of adult Dungeness crabs in British Columbia is clams. In Hecate Strait near the Queen Charlotte Islands where 116 prey species have been identified in the stomachs of the crab, juvenile Pacific Razor Clams (*Siliqua patula*) and the Alaska Bay Shrimp (*Neocrangon* alaskensis)] are a major component of the diet of Dungeness crabs. The crab will prey on Pacific Oysters (*Crassostrea gigas*) planted on the bottom at oyster farms. In Southeastern Alaska, Dungeness crabs have been observed eating various species of bivalves including the Pacific Blue Mussel (*Mytilus trossulus*), the Nuttall Cockle (*Clinocardium nuttallii*), and *Macoma* sp. Crabs were also seen carrying the Butter Clam (*Saxidomus giganteus*) and the Kennerley Venus (*Humilaria kennerleyi*) in their claws, presumably with the intent of eating them (Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). Dungeness crabs have been observed "digging-up" (to a depth of 0.3 m) and clutching large Nuttall Cockles (*Clinocardium nuttallii*) in Southeastern Alaska. The crabs will also scavenge animal flesh. They have been observed feeding on the carcasses of Pacific Halibut (*Hippoglossus stenolepis*) and unidentified flatfish in southeastern Alaska (Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). At San Juan Island in northern Puget Sound, Washington, adult Dungeness crabs move into the intertidal zone during nocturnal high tides, and feed mostly on bivalves and polychaetes. Elsewhere on the coast of Washington, crustaceans and fish are important food items in the diet of adult crabs.

Dungeness crab larvae are primarily zooplankton predators, although phytoplankton are also eaten. In the laboratory, the larvae can be raised to the megalopal stage with reasonably good survival on the diatom, *Skeletonema* sp. and the brine shrimp, *Artemia* sp.. Juvenile crabs (less than 10.0 cm in carapace width) eat primarily crustaceans in the Queen Charlotte Islands, British Columbia, and fish in California. In Grays Harbor, Washington, juvenile crabs eat primarily small bivalves and small crustaceans in their first year, shrimp (*Crangon* spp.) and fish in their second year, and fish in their third year. Both juvenile and adult crabs are cannibalistic, but the frequency of cannibalism is greatest in crabs less 6.0 cm in width, which prey on smaller crabs of the same year class.

The various life stages of the Dungeness crab are consumed by a diverse group of predators. The nemertean, *Carcinonemertes errans*, eats crab eggs and can cause heavy mortality (over 55%) in Dungeness crab egg clutches. In Oregon and northern California, the megalopae are preyed upon by King Salmon (*Oncorhynchus tshawytscha*) and Coho Salmon (*O. kisutch*) as well as by other fishes, such as the Copper Rockfish (*Sebastes caurinus*). Sea birds also consume the megalopae. In California, the Giant Pink Star (*Pisaster brevispinus*) preys on newly-settled megalopae and small juvenile crabs.

In addition to falling prey to larger conspecifics, juvenile Dungeness crabs suffer predation from a wide variety of invertebrates, fish, birds and mammals. In Grays Harbor on the outer coast of Washington, the Staghorn Sculpin (*Leptocottus armatus*) is a major predator of newly-settled Dungeness crabs in late spring and early summer; in Puget Sound, large juvenile crabs are found in stomachs taken from this fish. Crabs up to 11.4 cm in carapace width are consumed by the Pacific Halibut (*Hippoglossus stenolepis*) in Alaska and by the Cabezon (*Scorpaenichthys marmoratus*) in Oregon. Wading birds also prey on young crabs.

Perhaps the most important predator on adult Dungeness crabs in certain areas of Alaska is the sea otter (*Enhydra lutris*). The dramatic decline in crab abundance in Orca Inlet, Prince William Sound, beginning

in 1979 has been attributed to predation by sea otters which prey heavily on Dungeness crabs in Prince William Sound. Sea otter predation is also probably responsible for a recent decrease in the abundance of Dungeness crabs in part of Dundas Bay, Glacier Bay National Park, Alaska. Octopuses also prey on adult crabs. Intertidal juveniles and large crabs in poor health are subject to bird predation. Bald eagles (*Haliaeetus leucocephalus*), northwestern crows (*Corvus caurinus*), and gulls (*Larus* sp.) Have been observed eating the eggs of apparently previously healthy, ovigerous crabs that had been dug out of sand in which the crabs had buried themselves in the low intertidal zone (Robert Stone and Charles O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, personal observation). One or more of these birds had excavated the females and inverted them to gain access to the crab's egg clutch. Virtually every female that had been attacked in this way was dead by the time they were observed. The Dungeness crab is also infrequently preyed upon by river otters (*Lutra canadensis*) in southeastern Alaska.

What is the approximate upper size limit of juvenile fish (in cm)?
Male and female Dungeness crabs reach sexual maturity at 10.0 cm in width.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

ADF&G, Petersburg, AK Tim Koeneman, (907) 772-3801
ADF&G, Homer, Charles Trowbridge, (907) 235-8191
ADF&G, Kodiak, Daniel Urban, (907) 486-1840

Habitat and Biological Associations (if known) Narrative
Dungeness crabs are most common on sand or muddy-sand bottoms in the subtidal region, and are often found in or near eelgrass beds. However, in southeastern Alaska as well as elsewhere they can also be found on a variety of other substrata including various mixtures of silt, sand, pebble, cobble and shell.

Egg/Spawning See Adults

Larvae On the outer coasts of Washington, Oregon and California the zoeae are transported offshore. Subsequently, the megalopae are transported near shore, probably by wind-induced currents acting in conjunction with the diel vertical migratory behavior of the megalopae. Little is known of the movements and distribution of Dungeness crab larvae in southeastern Alaska. The megalopae have been observed among the gonozooids of the pelagic hydrozoan, *Velella velella*, collected 1-10 km from shore in northern California. The megalopae eat the gonozooids, gain protection from pelagic fish predators and possibly are transported to juvenile crab habitats nearshore while associated with the cnidarian. In northern Puget Sound, Washington, megalopae settle onto relatively open sandy areas where they are vulnerable to fish predation.

Juveniles Juvenile Dungeness crabs are found in similar habitats to the adults, but they generally occupy shallower depths than the adults. Juvenile crabs can be very abundant in the intertidal zone, but also occur in shallow subtidal areas. Survival of young crabs is greatest in habitats where they can gain refuge from predators such as in intertidal shell and eelgrass beds.

Adults In sand or muddy-sand the adult crabs frequently bury themselves so deeply that only their eyes, antennules and antennae are visible. Ovigerous crabs can bury themselves so completely that there is no visible indication of their presence on the surface of the sand. Crabs unencumbered by an egg clutch move very quickly, running on the tips of the walking legs. The crabs are especially fast over sand or mud bottoms where obstacles are lacking. In southeastern Alaska the amount of movement varies with the sex of the crab and the reproductive state of female crabs. On average, males move at a greater rate than females and ovigerous females move around less than males or nonovigerous females.

SPECIES: Dungeness crab, *Cancer magister*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season/Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	8-10 mo	NA	August - June	BAY, BCH, ICS	NA	S, MS		
Larvae	3-3.7 mo	Zooplankton, phytoplankton	June - September	BAY, ICS	P	NA		
Juveniles	0-2 yr	Crustaceans, bivalves, fish	All year	BAY, BCH,	NA	S, MS, G, CB, SAV		
Adults	2-8 yr	Bivalves, crustaceans, fish, polychaetes.	Spawning May - December	BAY, BCH, ICS	NA	S, MS, G, CB, SAV, M, SM		

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